SPARK

REPORT

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CONSTRUCTION WASTE MANAGEMENT REPORT

Prepared by
The SPARK Construction Waste Sub-Committee
of the
Science Council of British Columbia

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January 1991

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CONSTRUCTION WASTE MANAGEMENT REPORT

EXECUTIVE SUMMARY

1.0 Introduction

The Science Council of British Columbia's SPARK Construction Committee is dedicated to fostering the application of science and technology by the BC construction industry for the economic development of this sector of the provincial economy.

A major and highly visible concern of this sector is the generation and handling of demolition and construction waste.

The SPARK Construction Committee undertook a study of the present state of construction waste management in the province. The study was limited by its resources to reviewing practices in the Lower Mainland. It is not comprehensive, but does provide an overview of present practices.

The committee gratefully acknowledges the support provided by National Research Council's Industrial Research Assistance Program (IRAP) and SPARK.

1.1 Objectives

- To identify the sources and size of the waste stream to better determine management techniques.
- To review current construction and demolition waste handling practices.
- To identify successful waste management initiatives.
- To highlight entrepreneurial opportunities in waste handling.

1.2 Magnitude of the Waste Stream

The size of the waste stream could only be estimated because accurate statistics are not kept on the waste from this sector. The total is approximately 2.0-2.4 million tonnes from land clearing, demolition and construction through out the province. The Greater Vancouver Regional District (GVRD) accounts for approximately 30 per cent of the total.

The wastes are largely inert. The small portion of the total defined as hazardous waste is governed by legislation and is outside the scope of this report.

1.3 Characteristics of the Waste Stream

The majority of the material wastes are inert and are more problematic due to bulk than toxicity.

Construction waste has been documented in two studies that agree reasonably with each other. By volume there is 40 per cent wood, 18 per cent gypsum wallboard, 14 per cent cardboard, 10 per cent plastics, 6 per cent metals and small amounts of masonry, textiles and asphalt.
Demolition waste is poorly documented. A US Army study estimates the per cent by volume to be 53 per cent concrete, 13 per cent masonry, 33 per cent wood. In BC there would be a greater volume of wood and less of concrete.

The recycling industry needs regular generation of clean materials in 20 tonne loads to be economic.

1.4 Waste Management Hierarchy

Waste management is hierarchical, the higher in the list the lower the environmental impact. The five R's of construction waste management are:

REDUCE	Use less material.
REUSE	Use material again in its original form.
RECYCLE	Use waste material to make a new product.
RESOURCE RECOVERY	Reclaim energy or other resource.
RESIDUAL MANAGEMENT	Dispose safely of what remains.

1.5 Waste at each stage of the Lifecycle

Waste generation can be influenced at all stages of a project's life.

1.5.1 Design and Specification

The inputs for the project are decided at this stage. The efficient use of materials, the use of recycled materials, the use of durable and/or recyclable materials is controlled by owner and designer.

1.5.2 Construction

Wastes can be minimized by careful control of purchases, discouragement of labour only contracts, proper storage of materials and proper scheduling.

Reuse of unavoidable wastes can be maximized by careful separation.

1.5.3 Use and Maintenance

Wastes generated from the routine operation and maintenance of a project can cost the equivalent of the original capital cost of the project. Careful selection of durable and maintainable assemblies can have a major impact.

1.5.4 Demolition

The only course available at this stage is to remove the recoverables designed into the project and dispose of the residue safely.

1.5.5 Disposal Practice

Landfilling is the major disposal method for construction and demolition waste. Its popularity is assured because of the low cost. Construction waste is valued since it is inert and will improve the filled land for future development. Landfills in the Lower Mainland are filling rapidly. Costs are rising as the need for post closure monitoring and mitigation is recognized.

Ocean dumping is the destination for much of the excavation waste. The residual gypsum contaminated cardboard from wallboard recycling is also treated this way.

Recycling activity is increasing. Regulations will have a marked affect on future disposal practices.

1.6 Innovative Practices in BC

Several innovative uses and reuses of construction and demolition waste are underway in the province.

Asphalt from highways is recycled, some is even done on the spot.

Cardboard is a valuable resource and some source separation goes on at construction sites and some separation at landfills also occurs.

Scrap ready mix concrete is cast into large blocks used in retaining walls.

Gypsum is recovered from scrap wallboard and recycled.

Some landscaping waste is composted.

Some wood wastes are ground to reduce volume and some for energy generation.

Some paint is being recycled and some pigment recovery goes on.

A resource recovery project is underway at the Coquitlam land fill.

1.7 Initiatives Elsewhere

It was difficult to document with certainty what is successful in other jurisdictions.

Composting of landclearing wastes and other organic matter occurs in Washington State.

A Massachusetts company is reported to use oil contaminated soils to make cold mix asphalt.

Wood is banned from landfills in Peel County, Ontario. A company is shredding all the wood and it is currently used for landscaping material. Studies are underway to find higher value uses for the waste.

Results of some Swiss experience are presented.

1.8 Suggested Action

1.8.1 Direct Initiatives

These bear directly on the physical problem.

Design

Detail and design to minimize offcuts.

Specify durable and recyclable materials.

Allow the use of recycled materials.

Specify locally made materials.

Renovate sound buildings.

Site

Designate a site waste management supervisor.

Implement source separation.

Encourage reuse of offcuts.

Schedule to reduce waste of effort and material.

Construction Materials Manufacturing

Promote materials incorporating wastes.

Promote reduction in overpackaging.

Waste Handling

Encourage development of transfer stations for construction wastes.

Promote the development of separated waste containers.

1.8.2 Information Initiatives

Research

Studies are needed to quantify and characterize construction waste.

Case studies of site waste generation and handling.

Research environmental impact of construction materials.

Research the reprocessing of construction materials.

Legislation and Policy

Promote material recycling at construction waste landfills.

Promote separation and safe collection of hazardous wastes.

Encourage the use of recycled products and more environmentally sound materials through tax incentives.

Develop long term guidelines for construction wastes.

Consider differential fees for demolition permits to encourage renovation.

Review procedures and their enforcement for the disposal of hazardous construction wastes.

Education

Encourage development of conservation codes.

Implement a demonstration construction site project to educate the contractor and the public.

Establish levels of acceptable waste generation for each class of materials.

Develop a database to link each type of waste with its appropriate recycling or disposal techniques.

Market

Develop incentive programmes for recycling ventures.

Promote a market information exchange about construction materials available for recycling.

Provide better access by salvage businesses to recoverable materials before demolition.

Promote "green" constructors to the public.

Develop an award program for peer and public recognition.

2.0 INTRODUCTION

2.1 Context

Construction waste is considered an unavoidable part of a construction project. Since waste disposal costs are rapidly increasing and government regulations regarding waste handling and disposal are becoming more stringent, waste management is emerging as a significant issue. Unlike other sectors of society, construction waste is highly visible. Attention will increasingly be directed at the construction industry to ensure it is exercising sound environmental practices.

In a broader context, construction waste is symptomatic of the inefficient use of materials and resources, resulting in potential opportunities for cost savings and innovation. Currently little comprehensive information exists on construction waste and indeed on the economic benefits of more effective uses of materials. This study represents an initial review of current construction and demolition waste management practices in British Columbia.

The Construction Sector Committee of the Science Council's Strategic Planning for Applied Research and Knowledge (SPARK) in conjunction with the National Research Council's Industrial Research Assistance Program (IRAP) provided the funding for this report.

The study was conducted by a recent university graduate working full time and a project manager working one quarter time over four months under the direction of the SPARK Construction Waste Sub-committee.

2.2 Objectives

The objectives of the study were four fold:

- To identify sources of construction waste throughout the construction project lifecycle and thereby develop a more comprehensive view of waste management.
- To review current construction and demolition waste handling practices in British Columbia.
- To identify successful initiatives that were implemented in other jurisdictions for waste reduction and reuse.
- To identify entrepreneurial opportunities in construction and demolition waste management.

2.3 Scope and Limitations

At present, construction and demolition waste is poorly documented in British Columbia. The information in this report derives from: interviews with industry representatives; site visits; literature searches and the examination of documented studies undertaken in other jurisdictions. Most data which is available focuses on construction and demolition waste from buildings rather than all construction sectors, therefore an unintentional bias may be perceived.

While the study recognizes that construction waste occurs in many forms: solids, liquids, and gases which can have both direct and indirect environmental impacts, it focuses on the direct effects of handling solid waste materials.

2.4 Target Audience

This report is directed at:

- Construction industry representatives interested in adopting and implementing environmentally sound building practices.
- Companies and entrepreneurs wishing to invest in environmentally friendly construction practices and business ventures.
- Government agencies allocating research funding for non environmentally related issues.
- Policy makers responsible for developing waste management legislation.

3.0 MAGNITUDE OF CONSTRUCTION AND DEMOLITION WASTE

Quantifying construction and demolition (C+D) waste in BC is difficult because:

- accurate records of waste composition entering a landfill are not usually kept, or are not readily available;
- construction cycles fluctuate with economic conditions;
- construction materials and methods differ from region to region.

Using data from the Greater Vancouver Regional District (GVRD), Statistics Canada and studies in other jurisdictions, an initial estimate of C+D waste in BC was attempted.

3.1 C+D Waste Estimate Based on GVRD Data

The GVRD estimates the waste from construction, demolition and land clearing which ends up in the local landfills is between 500,000 and 700,000 tonnes per year. This represents between 30-40 per cent of the 1.7 million tonnes of waste generated in the GVRD each year. (Source: Waste Reduction and Recycling in the GVRD p. 1-3, 1989+ T. Allas).

Construction, demolition, and land clearing in the GVRD represent approximately 30 per cent of the total BC dollar investment in such activities. (Source: BC Government). Based on this, the total volume of C+D waste for the province can be estimated at 2.0 million tonnes per year. (See Figure 3-1).

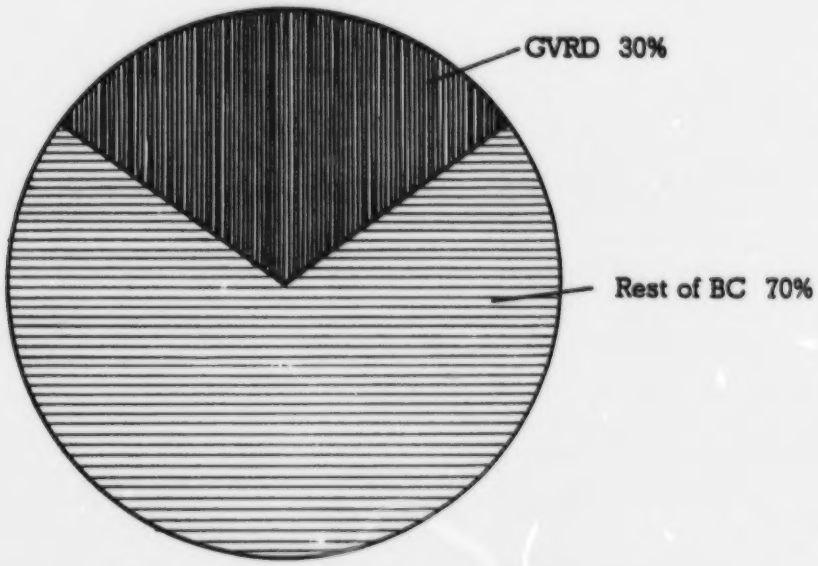
3.2 C+D Waste Estimate Based on Statistics Canada Data

To corroborate the above figures, a second estimate of C+D waste was performed using Statistics Canada 1988 data on residential demolition, new construction and renovation activity. The following numbers discussed are summarized in Figure 3-2.

In BC's residential sector alone, 3423 dwelling units were demolished in 1988. (Source: Statistics Canada). The amount of debris from an average demolished dwelling is 90 tonnes. This figure was derived by comparing studies of demolition waste from across North America (Source: US Army, ...) with local waste haulers estimates. Based on these statistics, the residential demolition sector generated over 300,000 tonnes of debris in 1988.

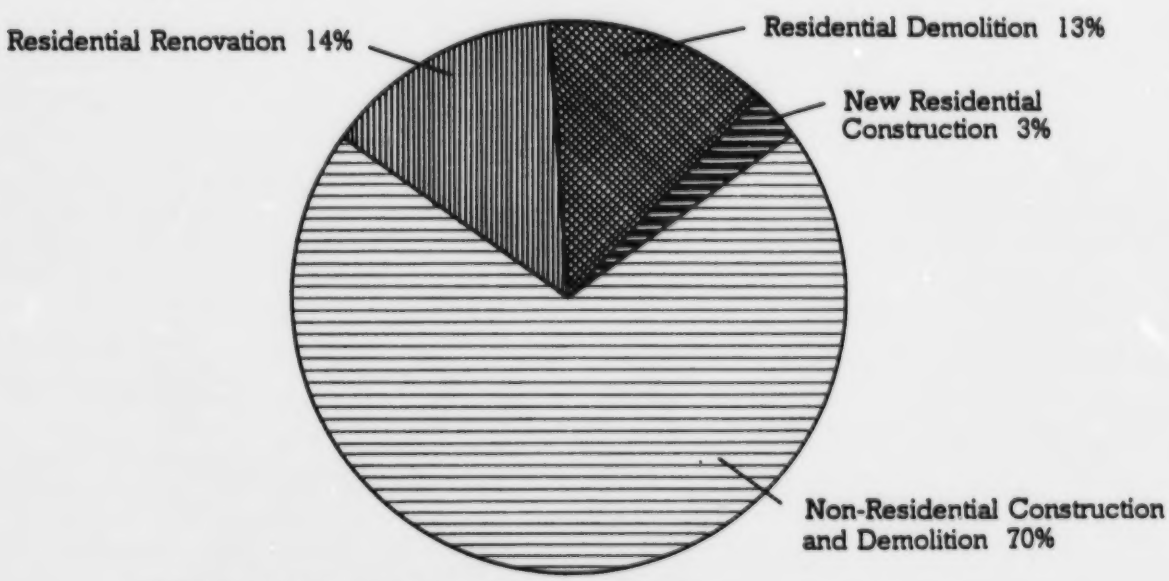
Although lower, waste generated from new residential construction is also significant. In BC 31,787 dwellings were authorized for construction in 1988. (Source: Statistics Canada). Using the figure 2.5 tonnes of waste per new dwelling the total is about 80,000 tonnes. (Source: Peel Region Waste Study, 1988).

Fig. 3.1 Construction, Demolition and Landclearing Waste in BC based on Greater Vancouver Regional District Estimate



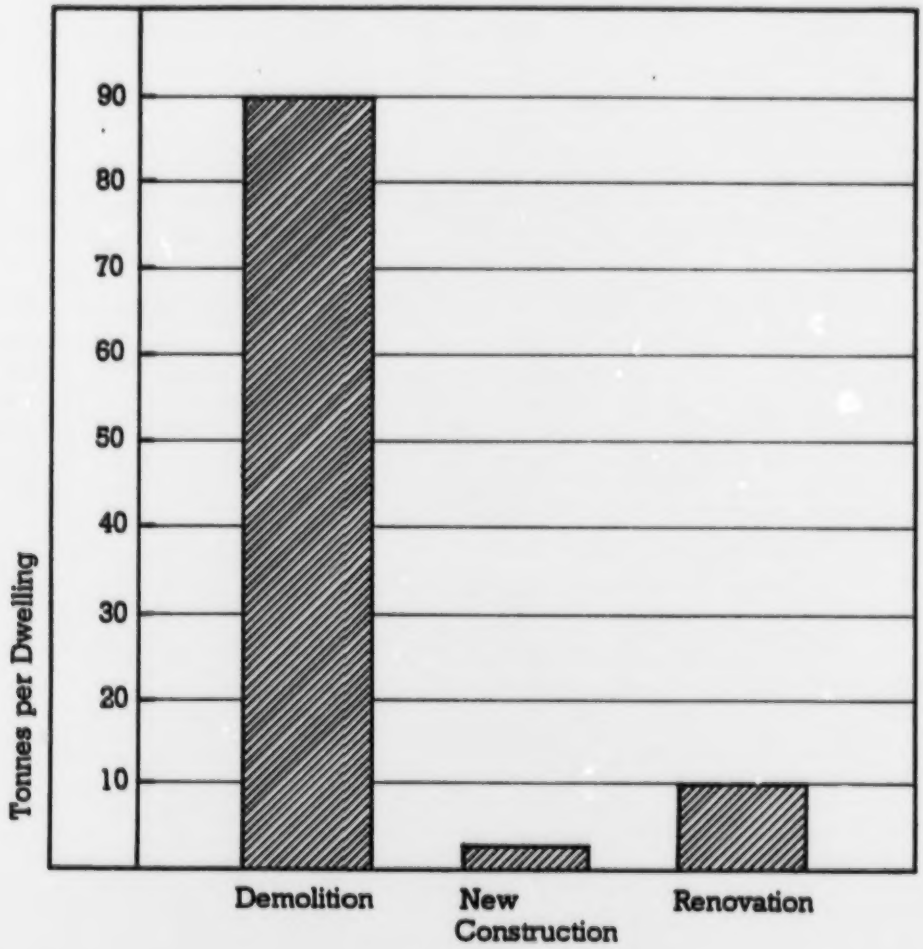
Total Construction, Demolition and Landclearing Waste Estimate
2.0 million tonnes

Fig. 3.2 Construction and Demolition Waste in BC based on Permits



Total Construction and Demolition Waste Estimate
2.4 million tonnes

Fig. 3.3 Waste Generated from Various Residential Construction Activities



According to the Canadian Home Builders Association, investments in residential renovations and new construction are approximately equal. However, the volume of waste from renovation is on average four times greater than new construction. (Source: Toronto Home Builders Association (THBA)). Therefore renovation waste amounts to approximately 320,000 tonnes and is of the same magnitude as demolition waste.

From the numbers derived above, residential demolition, new construction and renovation activities produce a total waste volume of 708,000 tonnes each year. The residential sector accounts for approximately 30 per cent of the total investment in all construction. (Source: SPARK Construction Report, p.6). Assuming other construction sectors generate comparable waste amounts per dollar invested, the total amount of construction waste generated in the province would amount to approximately 2.4 million tonnes per year.

The GVRD and Statistics Canada estimates for waste production differ by less than 20 per cent with an average of 2.2 million tonnes. Problems arise when comparing these estimates because the GVRD figure assumes an undetermined percentage of landclearing wastes which were not considered in the Statistics Canada estimate. The lack of accurate data on waste volumes impedes effective management decision making and indicates the need for a comprehensive study to monitor C+D waste production in the province.

4.0 CHARACTERISTICS OF THE WASTE STREAM

The majority of C+D wastes are inert and more problematic due to bulk than toxicity.

Special and hazardous wastes are outside the scope of this report. In buildings they include: asbestos from certain types of insulation; mercury from electrical switches; or the CFC's present in air conditioning systems. Although these waste products comprise a small portion of the waste stream, they can present significant environmental hazards. The handling of these materials is subject to strict procedures and is beyond the scope of this report. (See Appendix for references on disposal information).

A good understanding of what constitutes the C+D waste stream is a prerequisite for any waste management plan.

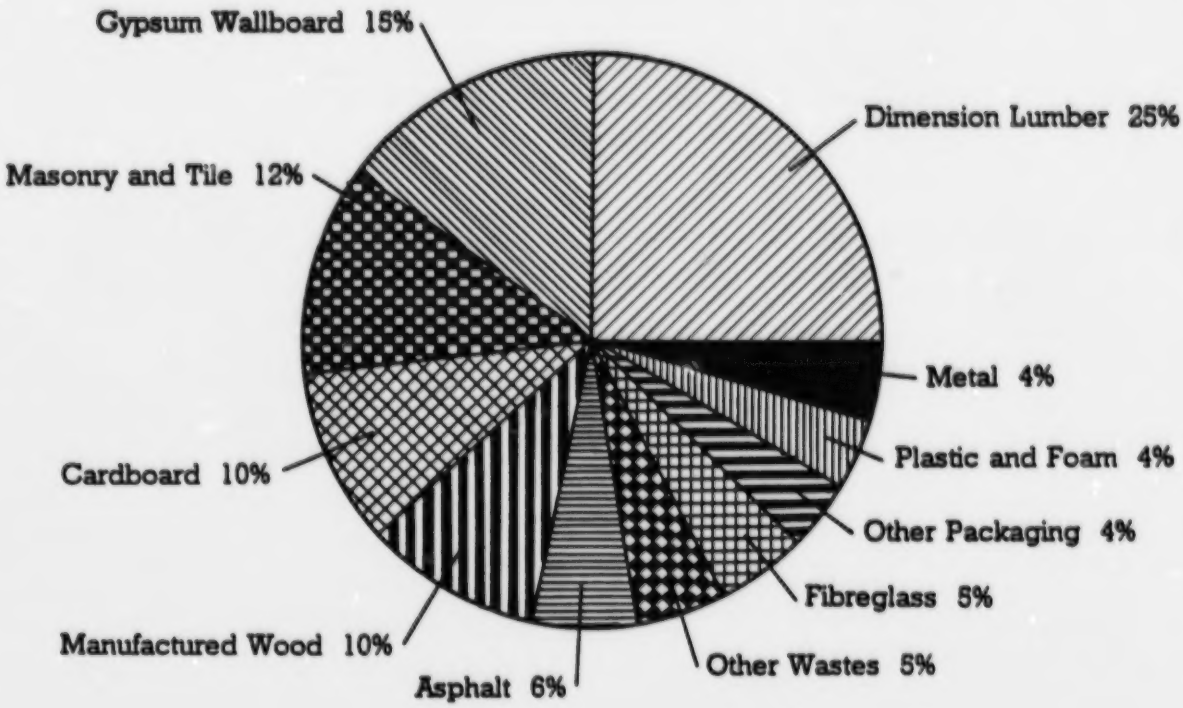
4.1 Waste from Construction

Construction waste is a mixture of unused or damaged materials, off-cuts, and packaging. Table 4.1 shows the results published in two studies on the composition of waste generated on construction sites. The first was undertaken by the Toronto Home Builders Association (THBA) and the second is from the Association of Whistler Area Residents AWARE for the Environment.

Table 4.1 Composition of Construction Waste (Per cent Volume)

WASTE CATEGORY	Per cent	Volume of Total Waste
	THBA	**Whistler**
Dimension Lumber	25	40 (all wood)
Manufactured Wood	10	
Gypsum Wallboard	15	18
Metal Wastes	4	6
Asphalt	6	
Masonry	12	
Plastics	4	10
Fibreglass	5	
Corrugated Cardboard	10	14
Packaging	4	
Other	5	7
Textiles		2
Chemicals		3
	100	100

Fig. 4.1 Composition of Construction Waste (by volume)



Wood, gypsum wallboard, cardboard and plastics are good candidates for recycling since the large volumes available favour economies of scale for waste recycling operations. The value of recyclable materials is increased if materials are pre-sorted to reduce handling costs and contamination. Materials having high inherent commercial resale value, such as metals, are most the suitable for recycling.

4.2 Waste from Demolition

Demolition waste is different from construction waste. It includes actual building components such as full length studs, concrete slabs and plaster.

No statistics can be found describing the composition of demolition waste in BC. A number of studies exist which describe the breakdown of the demolition waste stream in other parts of North America. (Source: Chatterjee-US Army). These study results are summarized in Table 4.2. The largest discrepancy to the conditions in BC is for wood waste. The amount of wood from demolition is likely to be underrepresented in Table 4.2 since more wood is used in BC than in many other areas of North America.

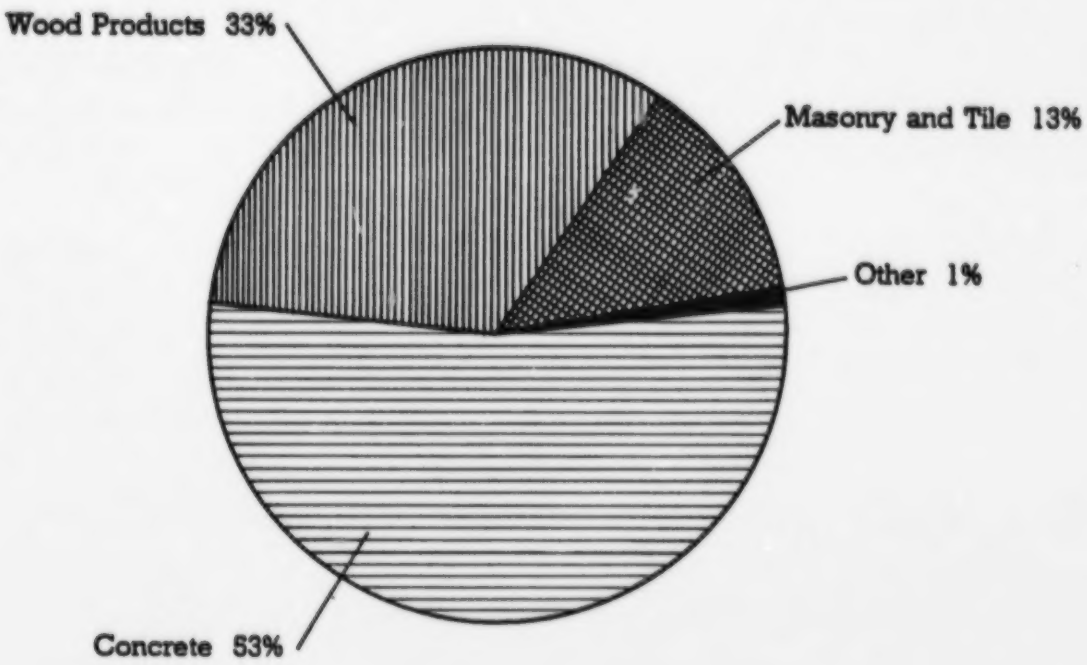
Table 4.2 Demolition Waste Composition North American Average
(Summarized from Chatterjee-US Army)

CONSTITUENTS	Per cent Weight	Per cent Volume
Concrete	67	53
Metals	2	-
Brick and Clay products	13	13
Wood products	13	33
Other	1	1
Total	100	100

Concrete comprises the largest proportion of the waste stream both by weight and volume. However, the volume of wood is also a significant portion of the waste stream. The materials generated in large quantities are the ones which can be handled by waste processing facilities.

Representatives from Wastech Services Limited, a company which operates a resource recovery plant in Coquitlam, state that clean materials must be regularly generated in truck load quantities of at least 20 tonnes to be of interest to recyclers. (See Section 7.2).

Fig. 4.2 Composition of Demolition Waste (by volume)



5.0 WASTE GENERATION THROUGHOUT THE PROJECT LIFECYCLE

A construction project goes through several distinct stages throughout its lifetime. Various wastes are created due to decisions or actions at each of the following stages:

- design and specification;
- construction;
- use, maintenance, and existence of the constructed project;
- demolition and disposal.

Waste generation is often influenced by more than one stage of construction. It is therefore important to consider the entire lifecycle of a construction project when analyzing the waste generation process and gauging environmental impact. A broad perspective is also valuable to ensure that limited funds for developing and implementing environmentally sound technologies are effectively allocated.

When considering the solid waste management technologies, certain techniques are preferred because they are less harmful to the natural environment. This hierarchy is known as the 5R's of waste management and is shown in Table 5.1. The higher the number on the table, the better is the solid waste management technique. The position in the table will also be affected by the local waste management facilities.

Table 5.1 Solid Waste Management Hierarchy

Management Method	Activity
1. Reduction	reduce consumption eg. use minimum material as required by plans, reduce packaging
2. Reuse	material is used again in its original form eg. reuse formwork, boarding
3. Recycling	at source separation of solid wastes and use the collected materials content for remanufacture into new products, also composting eg. grinding up old concrete for use as roadbed
4. Resource Recovery	reclaiming recyclable components and/or energy from the post-collection solid waste stream by various methods other than composting eg. Wastech Facility (See Section 8.2).
5. Residual Mgmt.	disposal, of what remains of the solid waste stream after the four previous activities, in an environmentally safe manner eg. landfilling, ocean dumping, burning without energy recovery

(Source: Adapted from, Environment Council of Alberta, 1985).

5.1 Design and Specification

The design process and the specification of materials directly controls the input into a construction project. Therefore, the design process plays a key role in determining construction waste. This means tomorrow's waste is designed and planned today. It was beyond the scope of this project to analyze the material selection process in depth, however a number of ways in which design and material selection decisions can effect the environment were identified.

MATERIAL SPECIFICATION OF:

- ❑ durable and recyclable materials;
- ❑ recycled or re-used materials;
- ❑ materials with low embodied energy and made with manufacturing processes with lower environmental impacts;
- ❑ locally produced materials to reduce transportation costs and fossil fuel consumption.

DESIGN INITIATIVES FOR:

- ❑ durability and maintainability;
- ❑ minimizing offcutting;
- ❑ awareness of market driven changes regarding the environmental friendliness of construction.

This list of considerations is certainly not complete. Even so, it demonstrates that the design phase has an important effect on waste generation and environmental impact. It is imperative that this awareness be increased in the community of architects and designers.

5.2 Construction

At the construction phase much of the waste is predetermined. Most of the required materials are ordered, manufactured and delivered. Yet, numerous ways still exist to minimize waste, reduce its handling costs and reduce its environmental impact:

- ❑ reduce materials wastage on site;
- ❑ prefabricate common elements at central locations;
- ❑ optimize construction scheduling;
- ❑ encourage on site re-use of cut-offs;
- ❑ separate recyclable materials.

According to estimates performed in the U.K. ten per cent of all materials brought to a construction site end up as waste. (Source:

Skoyles). This amount can be reduced by improved materials handling procedures. A clear materials control policy, overseen by the site superintendent is a good approach.

Materials wastage on site occurs for the following reasons:

- damage during transportation to the site;
- careless or inappropriate on site storage of materials;
- inappropriately ordered materials or materials ordered in surplus which are non-returnable;
- poorly planned materials delivery schedule;
- damage to finished portions by other subtrades or vandals.

The reduction of this type of C+D waste is particularly attractive, because all reductions will translate directly into increased profits. However, since increased materials handling may increase labour costs, the materials cost saving versus labour cost increase tradeoff must be made in each case.

With some planning and organization, the volume of waste can be significantly reduced by reuse on site. Examples include using two by four end cuts for bridging, or waste sheet metal for patches.

Source separation of recyclable material will reduce waste sent to a landfill. Sorting on site is preferable to post-collection sorting because this minimizes contamination. Case studies showing the benefits of source separation for both construction and demolition are found in Sections 7 and 8.

The trend to use more factory built components (e.g. structural parts) which are assembled on site, will shift some waste generation from the site to the factory. This can have a beneficial effect on waste management since, the waste generated in a factory is usually a consistent composition, uncontaminated, and generated at a regular rate. These are all important factors which facilitate reuse and recycling.

5.3 Use, Maintenance and Existence

Regular maintenance and cleaning activities generate waste. In addition, wastes result from the replacement of low durability materials with a life span shorter than the building, such as roofing and carpeting. These wastes would also include other items which have to be replaced before the end of the structure's lifetime.

The following example shows the high cost of replacing these less durable materials over the lifetime of a building. Figure 5.1 illustrates

Fig. 5.1 Depreciation of a Building Without Maintenance

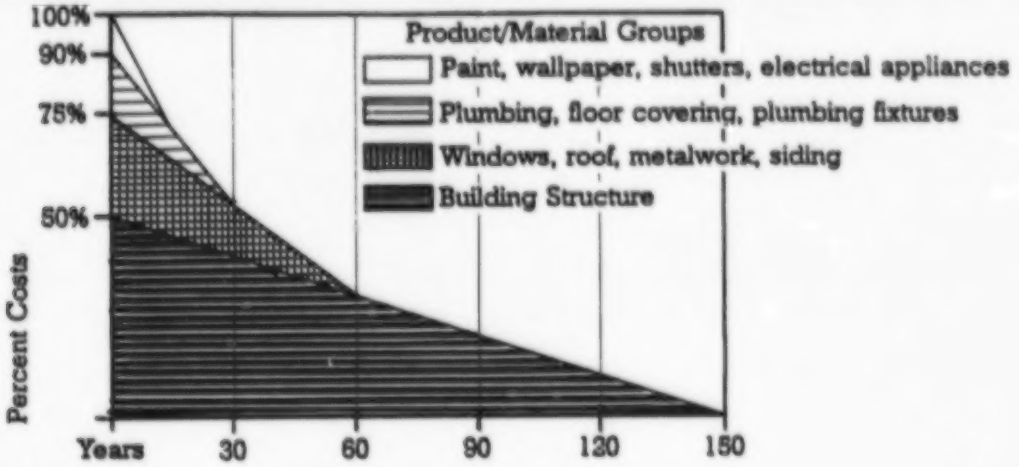


Fig. 5.2 Depreciation of a Building With Regular Maintenance

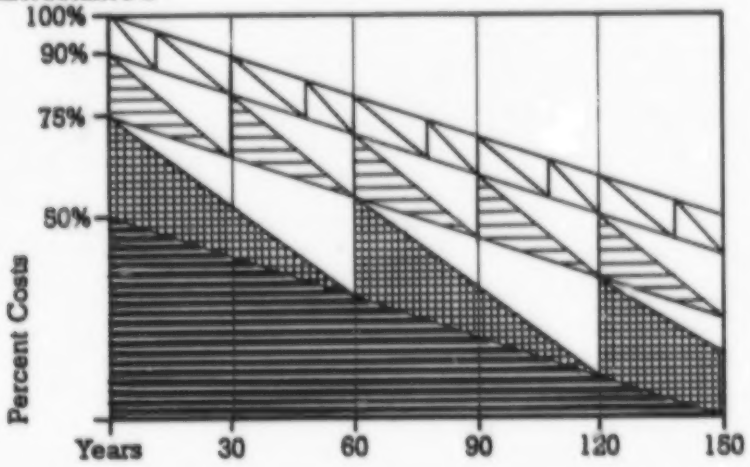
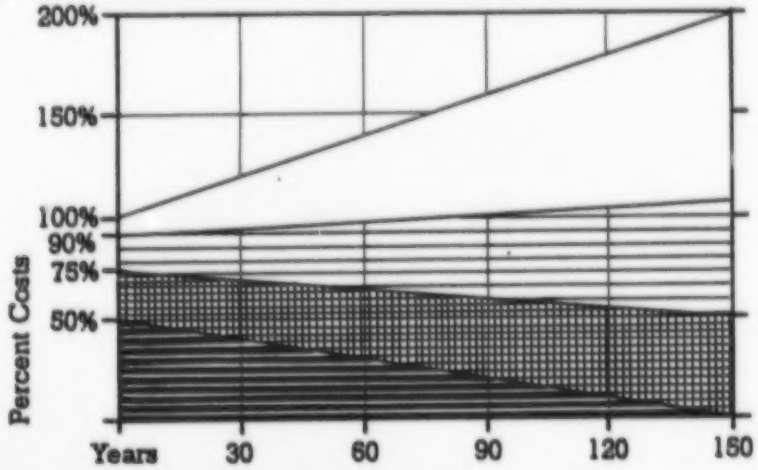


Fig. 5.3 Cumulative Maintenance and Repair Costs



the depreciation of a building with no maintenance. It also shows the different periods to total depreciation for the four different products/material groups.

Figure 5.2 shows the scenario where regular maintenance and repairs are carried out to maintain the building value at the remaining value level of the structure, group A. For the groups B, C, and D depreciation is compensated by regular investments required for the upkeep.

When the building was originally built, the costs of groups B, C, D represented about 50 per cent of the total investment. It is interesting to note the total costs for these three groups of components eventually surpasses the total original construction costs, as shown in Figure 5.3. This is due to the shorter renewal cycle required for these groups of components.

Costs can be approximated to waste generated during the building's lifetime and at demolition. Therefore, as the costs of the less durable components become significant, careful evaluation of these materials and of the maintenance and repair requirements during the entire lifetime will have a positive impact on waste.

Mixing materials with different lifespans is negative from the waste point of view. Maintenance or renewal can only efficiently take place if components can easily be accessed, and repaired or replaced. If different materials are tightly mixed or bonded, the one with the shortest lifespan will dictate the lifespan of the complete assembly and essentially force the waste of all the other materials involved.

A good example of this is plastic products embedded in concrete structures, such as sandwich construction techniques used in prefabrication. Plastic has a shorter lifespan than concrete and once it starts to deteriorate no repair is possible. This shows how initial cost savings can result in greater amounts of waste and financial costs in the future.

5.4 Demolition and Disposal

Demolition generates close to 50 per cent of the total C+D waste. Unfortunately, once the demolition stage is reached, all the factors influencing the amount and composition of waste have been determined at previous lifecycle stages. All that remains is to dispose of waste in the best possible way. Salvaging metals,

plumbing fixtures, glass, etc., and removing contaminants such as gypsum board can aid in recycling at this stage.

The objective must be to route the waste away from the landfills, towards reuse and recycling. Most materials going to the landfill are basically lost, and may even create problems in the future. If materials are brought back into a production process, they can be of use. Several initiatives to reduce the landfilled volumes of demolition waste will be discussed in the Section 7.

In summary, different methods of waste management and reduction become important during each construction phase. This is illustrated in Table 5.2.

Table 5.2 Changing Emphasis on the Different Waste Reduction Methods During Construction Phases

Waste Management Approach / Phase	Reduction	Reuse	Recycling	Resource Recovery
Design and Specification	most important	some		
Construction	some	important	most important	some
Use, Existence and Maintenance		some	important	
Demolition		important	most important	most important

6.0 CONSTRUCTION AND DEMOLITION WASTE DISPOSAL

Several options exist for the disposal of C+D waste: landfilling, incineration, ocean dumping and recycling. In BC, landfilling is currently the most popular waste disposal option. However, environmental concerns and the limited amount of available landfill space will undoubtedly cause disposal practices to change in the future. The following Sections examine current and future C+D waste disposal options for BC.

6.1 Current Waste Disposal Options

6.1.1 Landfilling

Operation and Costs

There are two main types of landfills: municipal and private. Landfills run by municipalities are permitted to accept municipal and industrial wastes of various types. Private landfills are only permitted to accept inert waste materials such as those from construction, demolition and landclearing. Due to the lower costs of handling the inert materials, the dumping fees at private landfills are lower than the dumping fees at municipal landfills.

Currently, 16 private landfill sites are available in the Greater Vancouver Regional District (GVRD). The tipping fees at private landfills are based on a straight volume charge. Hauling costs to transport wastes also vary according to the distance and the composition of the load. Generally tipping fees range between $75-$125 per 30 m^3 load depending on the landfills proximity to Vancouver.

In comparison, the three municipal landfills in the GVRD charge $69 per tonne for wastes, resulting in tipping fees ranging from $165-$930 per 30 m^3 load. This cost excludes transportation fees to a landfill.

Many areas in BC have a single landfill which handles all local waste. Disposal costs range from no charge to the GVRD rate. Compared to other areas of BC, the disposal costs in the GVRD are the highest. Rates in Toronto average about $100 per tonne or double the GVRD rate.

The Provincial Waste Management Act regulates waste disposal in the province. This Act requires that permits be acquired for any waste

discharge. The permits define operating practices for landfills and are monitored by the provincial Ministry of the Environment. The current maximum penalty for violation of the act is $5 million. The following list outlines acceptable and non-acceptable materials taken from a typical private landfill permit.

Acceptable materials:

- concrete;
- concrete waste and dust;
- concrete and road material;
- weathered asphalt;
- bricks;
- roofing material;
- residue from renovations and new construction;
- clean earth fill;
- framing lumber.

Unacceptable materials:

- putrescence wastes;
- food wastes;
- metal cans;
- hog fuel and sawdust;
- furniture and household appliances;
- liquid or semi-solid wastes;
- gypsum except incidental remnants from demolition;
- special waste eg. toxic, explosive, or corrosive;
- treated woods.

At private landfills, the prohibited materials which are recovered from the freshly dumped loads are returned to the waste haulers for appropriate disposal. Appliances and gypsum are taken to recycling operators. Special waste such as liquid paint and solvents are sent to companies specializing in hazardous waste disposal. The cost of sending a drum of hazardous waste for disposal in a registered disposal facility outside of BC is between $200-$500 per drum.

Concerns

Two main concerns exist regarding private landfills: the capability of operators to fully monitor the wastes entering the landfill, and the possibility that operators may be tempted to accept illegal wastes. These wastes may contaminate the land and cause future leachate problems.

Private landfill operators say these concerns are unfounded. They state that operators owning the land where fill is accepted have a vested interest and take great care in maintaining the land's quality for future development. For this reason, they would not knowingly accept waste which would jeopardize the land's development potential. (Source: Ecowaste and Burns). Where the operator is not the landowner, there may be more cause for concern.

Proponents of landfills argue that the inert fill from demolition and landclearing is needed to improve low quality land for development and is a safe and cost effective disposal method. (Source: Lloyd Campbell-Ecowaste). However, according to the Ministry of the Environment, the apparent low cost of landfilling compared with other disposal alternatives can be inaccurate. This underestimation occurs because only the operating costs of landfills are often considered while the costs of closure or post closure monitoring are ignored. (Source: Solid Waste Management Strategy For BC, p.9). These costs include: the final encapsulation over the landfill with acceptable drainage controls and vegetative cover; a system cost to monitor leachate and gas emissions; and money for remedial measures if environmental problems are detected. This means apparently low short term costs may result in greater long term costs.

6.1.2 Incineration

Formerly a large portion of C+D debris was burned on site or in local landfills. This open burning is being severely restricted due to air quality concerns. (Source: Doug Grant and Ministry of the Environment). However, incineration of waste in a modern facility with careful controls on air quality is being considered as an alternative. In the GVRD, an incinerator which opened in 1988 burns 20 per cent of the regions municipal garbage producing steam which it sells to local industry. Some industries burn certain wood wastes in their power boilers (eg. Scott Paper).

Burning waste in a carefully regulated incinerator, generates significantly less air pollution than open burning. Even so, there is still significant public resistance to expanding incineration as a waste management option due to air quality concerns. (Source: BC Ministry of the Environment, p.9, Municipal Solid Waste Management Task Force). Nonetheless, in the future, there will undoubtedly be more pressure to include incineration as a waste management option due to the rising cost of landfills.

6.1.3 Ocean Dumping

Ocean dumping is another alternative to landfilling. Currently in the GVRD large volumes of excavating waste is ocean dumped off Point Grey. Environment Canada estimates over 560,000 tonnes of

landclearing debris was dumped in 1989. In addition approximately 3,000 tonnes of gypsum wallboard which could not be recycled was ocean dumped off the west coast of Vancouver Island. This waste was not included in the GVRD estimate used in Section 4. It is however considerable, representing a volume almost equal to the amount of construction, demolition and landclearing material which is landfilled in the GVRD each year.

Ocean dumping is currently one of the cheapest methods of waste disposal. However, more stringent testing by Environment Canada is restricting the types of materials which can be ocean dumped.

6.1.4 Recycling and Reuse

Recycling and reuse of C+D waste has always occurred on a small scale in BC. Recently several new initiatives dealing with specific wastes materials have emerged. These activities are due to entrepreneurs viewing waste products as resources with a marketable value.

Specific initiatives concerning asphalt; cardboard; concrete; gypsum wallboard; metals; used building materials; and wood wastes will be discussed in Sections 7 and 8.

6.2 Future Waste Management Practice in BC

This Section examines future options for waste handling in BC. Published reports from across North America and interviews with local government officials and industry representatives were used to develop this Section.

6.2.1 Landfilling Future Outlook

The preference for landfilling is its convenience and low cost compared to other disposal options. However C+D waste disposal methods are likely to change in the future. The Ministry of the Environment predicts that 60 per cent of BC landfills will close within the next ten years. This fact along with the stringent environmental standards for new landfills will cause landfill costs to rise and will reduce the economic attractiveness of landfilling.

Replacing current landfills will be difficult due to land use conflicts in highly populated areas and public concerns regarding environmental impact. (Source: Ministry of the Environment Report, p.9). Indeed several municipalities have already failed to find politically acceptable replacement landfill locations in their jurisdictions. (Source: Stringer and Ministry of the Environment).

Closure of landfills in the Northeastern United States reveals what can happen when municipalities lack proper dumping locations. Since legal disposal alternatives were too costly, loads of waste were dumped

by the roadside. Either cost effective disposal alternatives must exist or there must be an effective system to enforce proper waste disposal. There is a need for practical long term solutions generated through consultations between government and industry.

Some regions with limited landfill space, but with recycling alternatives, banned landfilling certain materials. Currently, there is a partial ban on cardboard in the Toronto area. Landfills near Toronto will not accept loads of waste containing more than 20 per cent cardboard. The cardboard is separated and sent to local recycling facilities. The region of Peel in Ontario also banned the dumping of wood in its landfill. This ban coincided with the opening of a wood waste recycling facility near the landfill.

BC Ministry of the Environment sources say that there are no immediate plans for bans of materials from local landfills but if recycling options can be proven feasible, then bans will likely be implemented. The materials identified as possible candidates for banning include clean wood, plastics, cardboard and metals. (Source: Doug Grant and Ministry of the Environment).

6.2.2 Regulatory Initiatives

Toronto City Council is considering requiring developers, of projects larger than 25 units, to submit detailed solid waste management plans for approval. These plans would outline reuse and recycling for materials which normally are landfilled or incinerated. Demolition permits in Vancouver require plans which specify how demolition wastes, contaminated with asbestos and transformers containing PCB's, will be disposed. However, no requirements exist for the handling of non-hazardous materials.

By regulating materials used in construction, government has a significant impact on future waste generation. A good example is the elimination of PCB's in transformers and fluorescent light ballasts. Action was also taken to regulate the use of CFC's in the production of foam insulation. In California, legislation exists limiting and eventually reducing the use of oil based paints which produce significant air pollution. These types of bans eliminate current and future disposal problems. Experience also shows that bans can make a significant difference, while limits or partial bans have only a small impact.

Government plays a key role in stimulating consumption of environmentally friendly materials. By specifying the materials for its own development activities, the market for recycled products is supported and the price differential to conventional products is reduced.

By influencing the materials used in new construction projects, the quantities of construction and future demolition waste can be significantly reduced, and the waste content controlled.

Consumer demand is also a significant factor in promoting environmentally sound construction practices. Numerous polls indicate that consumers are interested in purchasing "green" products. With proper communication and education, building materials and entire projects which are environmentally friendly have an attractive selling point.

7.0 INITIATIVES IN B.C.

A large number of activities already exist in BC to reduce, reuse and recycle C+D waste. Each resulted from an entrepreneur viewing a waste product as a resource with marketable value. Following are several examples of innovative C+D waste management and handling initiatives taking place in BC. (The list is incomplete. The SPARK Committee would like to hear from any other new C+D waste managers not mentioned in this report).

7.1 Waste Materials Handling

7.1.1 Asphalt

Several companies recycle asphalt and concrete for roadbuilding in BC. One company reported it could not get enough recyclable materials to cover the demand. This company noted that some municipalities were wary purchasing recycled asphalt pavements because they believed it was an inferior product. Studies show recycled pavement is similar to asphalt made from virgin materials. (Source: Government Library References).

Pyrotech Asphalt Equipment Mfg. Co. Ltd. of North Vancouver has developed a new machine. It recycles pavement in situ by heating, stripping and remixing in one continuous operation. The Pyrotech process can rejuvenate the road surface to its original condition adding only minimal amounts, if any, of new aggregates and oil. The advantage is that transportation of materials to and from a processing plant is eliminated. (Source: BC Business Vol.2 #3, p.8).

7.1.2 Cardboard

Large amounts of cardboard are used in the packaging of construction materials. Site observations indicate the cardboard is put into bins without being flattened. This creates air pockets in the bin which increases waste volume and total waste hauling costs. In addition, cardboard is readily contaminated by other waste so it loses its recycling value.

If there is a sufficient volume of clean cardboard, (two cubic meters) several companies in the Vancouver area will pick up and deliver it to local processors for recycling. Paperboard Industries in Burnaby currently pays $40 per tonne for cardboard delivered to its plant.

7.1.3 Concrete

Concrete waste is created when either too much is ordered by a contractor, or a load fails to meet specification. Formerly this waste was landfilled or left to harden and crushed for reuse as aggregate.

United Lock-Block Ltd. now supplies 75x75x150 centimeter forms to concrete mixing companies to mould it into useful concrete blocks.

The blocks are sold for use in gravity retaining walls. The forms make use of waste ends of pre-stressed cable for lift hooks and waste transmission fluid as the release agent. This company currently has 65 locations in BC, Alberta and Washington State and plans to expand with franchise locations. Currently this process recovers 50 per cent of the concrete waste stream.

Concrete which has set or concrete from demolition is recycled by some roadbuilding companies and ready mix operators. These companies take clean loads of waste concrete and crush it to form aggregate for road bases and new concrete.

7.1.4 Gypsum Wallboard

Gypsum wallboard poses an environmental problem when it anaerobically degrades in moist landfills creating noxious hydrogen sulphide gas. This resulted in the banning of gypsum waste from landfill disposal in the Lower Mainland. Consequently all gypsum wallboard waste had to be ocean dumped.

After several years of grinding wallboard for more efficient ocean dumping, New West Gypsum developed a method to separate gypsum from the paper coating. Approximately 30,000 tonnes per year or 90 per cent of all the waste gypsum wallboard generated in the Lower Mainland is recycled through the New Westminster plant. The recycling process reduces the material which is ocean dumped to 3,000 tonnes of cardboard and residual gypsum. All the recovered gypsum is sent to local manufacturers to be made into new board with 20 per cent recycled content.

7.1.5 Landclearing Waste

Currently several companies are shredding landclearing waste into hog fuel for low grade farm roads. Very green material is ground and undergoes some natural composting forming a low grade potting soil. Some chipped material is burnt and some recovered as fiber to be made into manufactured goods. A company in Aldergrove called E.P.S. Recycling Incorporated is grinding wooden demolition waste, reducing its volume before trucking it to a landfill.

7.1.6 Metals Recycling

Metals recycling has been done for a long time. High quality heavy gauge metals are refined into ingots by local companies. Most of the steel collected locally is sent by scrap dealers to the U.S. or overseas for resmelting. Many scrap dealers will pick up and pay for scrap metals if there is a sufficient quantity.

7.1.7 White Good Recycling

Sometimes white goods or appliances are salvaged for their metal content, but often they are mixed in with demolition rubble. White goods pose special disposal problems from asbestos in water tanks, to CFC's in air conditioning and PCB's in old transformers. These hazardous materials add extra costs to the metal recycler. Programs dealing with the problem of freon in waste appliances are being put in place by the GVRD.

7.1.8 Paint

Ames Paints Ltd. of Victoria, has a pilot project investigating the recycling of liquid paints. Paint was collected from local residents on a specially designated hazardous materials collection day. The residual paints are processed making a new paint which contains one-third recycled content. Initial product was bought by the provincial government. Retail sales of the product range began this fall.

International Solvents Corp. in Surrey operates a kiln which incinerates sludge from paint manufacturers. The recovered ash contains rare and valuable titanium dioxide, a whitener and brightener in paint. The company is also experimenting with recovering other metallic components from paints.

7.1.9 Used Building Materials

Several companies strip valuable fixtures from houses before demolition and sell for scrap or reuse in other construction applications. The price is generally half that of buying new materials.

The types of materials recycled include: windows; doors; dimension lumber; moulding; wiring; electrical and plumbing fixtures; and appliances. This business has potential to expand when new markets for the used materials are found. Currently the major market is do-it-yourselfers doing small scale renovations.

7.2 Mixed Waste Handling

7.2.1 Resource Recovery

Resource recovery is reclaiming recyclable components and/or energy from the post collection solid waste stream. This process includes manual and machine sorting.

A major facility for resource recovery is Wastech Services Ltd. in Coquitlam. Located at the entrance of the Coquitlam landfill, it diverts a portion of the municipal, industrial and commercial waste destined for the landfill. Wastech recovers recyclable material from the diverted portion. Fuel pellets are formed from the remaining burnable wastes and are sold to local industries.

The waste received by Wastech is primarily from industrial and commercial operations. Differential costs of disposal are charged to companies depending on the type of waste and the level of contamination. Wastech is paid by the GVRD for the waste it diverts from the landfill. This payment system from the GVRD is structured to favour recycling over the production of refuse derived fuel.

7.2.2 Construction Source Separation

A preliminary experiment in construction source separation is underway at Quadrant Development which is studying the feasibility of separating materials and sending them to Wastech for processing. The project is a 74 unit, woodframe, lowrise residential development in Vancouver. Waste materials are being separated into: wood; metals; bricks and concrete; cardboard; gypsum wallboard and "other waste." The "other waste" includes: pressure treated woods; tar paper; plastics; and other miscellaneous waste.

The site superintendent at Quadrant is enthusiastic about the preliminary results of source separation. The costs of sending clean loads of wood to Wastech average $260 per load. This is slightly more than the $250 that was being paid to send a load to the local private landfill.

He estimates the loads he sends to Wastech are approximately twice as dense as conventional loads and therefore savings are realized. In addition, he dumps clean fill (cement, bricks and blocks) free of charge and will receive payment on the metals and cardboard which he sends for recycling.

Moderate amounts of policing and education on site ensures worker cooperation. Final results will be available on exact costs and benefits for this project in the spring of 1991.

7.2.3 Waste Transfer Facilities

Several smaller private companies operate as so called waste transfer facilities. These facilities accept loads of construction and demolition waste without a high number of contaminants, and special or hazardous materials. At these operations, the loads are dumped and spread apart by a back-hoe or a cat. Any materials which are valuable such as metals are picked out by hand and sent to appropriate locations for recycling. The remainder is repackaged and sent to a landfill.

Often contaminants are present in a load of waste. These are picked out and the waste hauler is charged a premium for their removal. The undesirable contaminants which commonly occur include: gypsum wallboard; plastic; metals; cardboard; tires; batteries; and mattresses.

The transfer facility operators charge the same fees as landfills but are more conveniently located to attract business. As well as recovering valuable materials such as metals, profits are generated by sending out loads of waste which are much more densely packed than when they arrived at the transfer station.

7.2.4 Waste Exchange

The BC Waste Exchange is a government supported directory which identifies companies that produce reusable or recyclable waste. Approximately 400 companies are listed in the directory. There is a large potential for expansion of the information network, and the identification of uses for the various waste materials. The system of waste exchange benefits both the producer and the consumer of waste material by reducing the former's disposal costs and giving the latter a new source of raw materials. (See Appendix for phone number).

7.3 Subtrade Waste Handling

A major development firm, Dominion Construction Ltd., instituted a policy of making all the subtrades responsible for their own waste disposal. This adds more time for the site superintendent to police clean up but reduces the general contractor's on site waste costs. The idea favours recycling, since subtrades are better able to separate specific recyclable materials as waste is generated. In addition, because subtrades are responsible for disposal they have a vested financial interest in reducing the volumes of waste generated.

This approach is one of the three corner stones of the C+D waste management project initiated by the Construction Industry Association in the city of Basel, Switzerland. The project is described in Section 8.3.2 of this report.

8.0 INITIATIVES AND PROJECTS OUTSIDE BC

The following Section outlines C+D waste management activities which are underway in jurisdictions outside BC. The list is by no means exhaustive, but contains random examples based on information gathered during the course of the study.

8.1 Materials Recycling

8.1.1 Building Materials from Waste

American Reclamation Corporation (AmRec) of Massachusetts is producing cold mix asphalt from a blend of oil contaminated soil; asphalt roofing materials; and varying amounts of concrete; brick and tile. This procedure has a large resource supply because many property owners are keen to get rid of oil contaminated soil.

Processes also exist using waste materials like flyash as cement replacement in concrete. On an experimental basis crushed glass, waste concrete and used tires were used to build roads. As well, there are patented processes to use ground and sorted demolition rubble to produce bricks and building panels for use in new construction.

8.1.2 Gypsum Processing

In Alto Michigan, a farmer grinds up gypsum wallboard replacing the lime he once spread on his corn crop. No results are available to establish the success of this practice. Indeed it raises several questions as to possible contamination from other waste materials. In the Lower Mainland, garden and fertilizer distributors stock granular gypsum as a soil conditioner. It provides calcium and soluble sulphate sulphur to problems soils, primarily those high in sodium. This occurs in some areas of BC.

8.1.3 Recycling Building Components

Architectural Clearinghouse is an Edmonton based non-profit company which created a computer directory of used building materials. This directory catalogues saleable building materials in structures which are scheduled for demolition. Builders can incorporate these products in new construction. This is an improvement over the traditional method of a storage yard for selling used materials because potential buyers are able to find out what is available without visiting a storage site. Also, storage costs are eliminated since materials are collected from the demolition site by the purchaser.

8.1.4 Waste Wood Processing

Waste Conversions Incorporated (WCI) opened a $2 million wood processing facility in the region of Peel outside Toronto. Wood waste comprises about 10 per cent of the region's waste stream and is banned from landfill. The facility accepts all types of wood including:

plywood; particle board; sawdust; broken skids; brush; and treated woods. The end product is a shredded mixture of hard and soft wood. WCI is selling the mulched material to the regional government for ground cover.

8.2 Mixed C+D Wastes Processing

Different systems for processing C+D waste are sold in the United States and Europe. These systems are similar to the Wastech facility in Coquitlam, however, they are specifically designed to handle C+D waste rather than mixed industrial waste. Several different mechanical and manual processes separate wood, metals, cardboard and building rubble. The building rubble is sorted according to size for sale as aggregate and the wood is sold as fibre or used as fuel. Two of the main manufacturers are Lindemann from New York and Bezner from West Germany.

A company in California called Norcal developed a special patented process which uses flotation ponds to separate wood from concrete and asphalt rubble. A conveyor pulls settled debris from the bottom and another skims wood from the surface. The wood is ground up for fuel. Metal scraps are resmelted and the remaining building rubble is crushed and sold as fill.

A facility in Washington State called Pacific Topsoils is currently receiving construction, demolition and landclearing wastes for processing into soil and other landscaping materials. These materials are mixed with organic materials such as garden cuttings and sewage sludge. The company charges varying tipping fees depending on the type of waste and the amount of processing required for the load. The various wastes are mixed and composted in windrows. Monitoring ensures all health standards are met by the compost material before it is sold for landscaping and soil enrichment.

8.3 C+D Waste Management in Switzerland

During the course of the study, the committee became aware of two C+D management projects taking place in Switzerland. They are reported as examples.

8.3.1 A Case Study in Source Separation

Translated and summarized from an article by Peter Staub in Bau Bio Bulletin, Feb 1990.

In Switzerland, the source separation of construction and demolition waste proved environmentally sound and financially rewarding compared to the traditional practice of landfilling.

Materials from a site are sent in separate specially marked bins to local recycling facilities. Separation depends on the local facilities available

Fig. 8.1 Waste from Apartment Demolition in Switzerland Using Traditional Methods

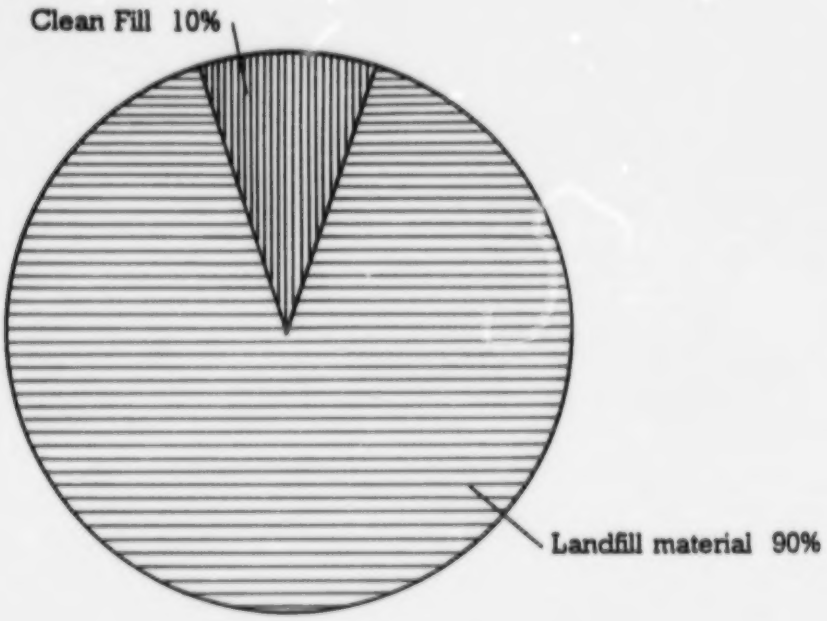
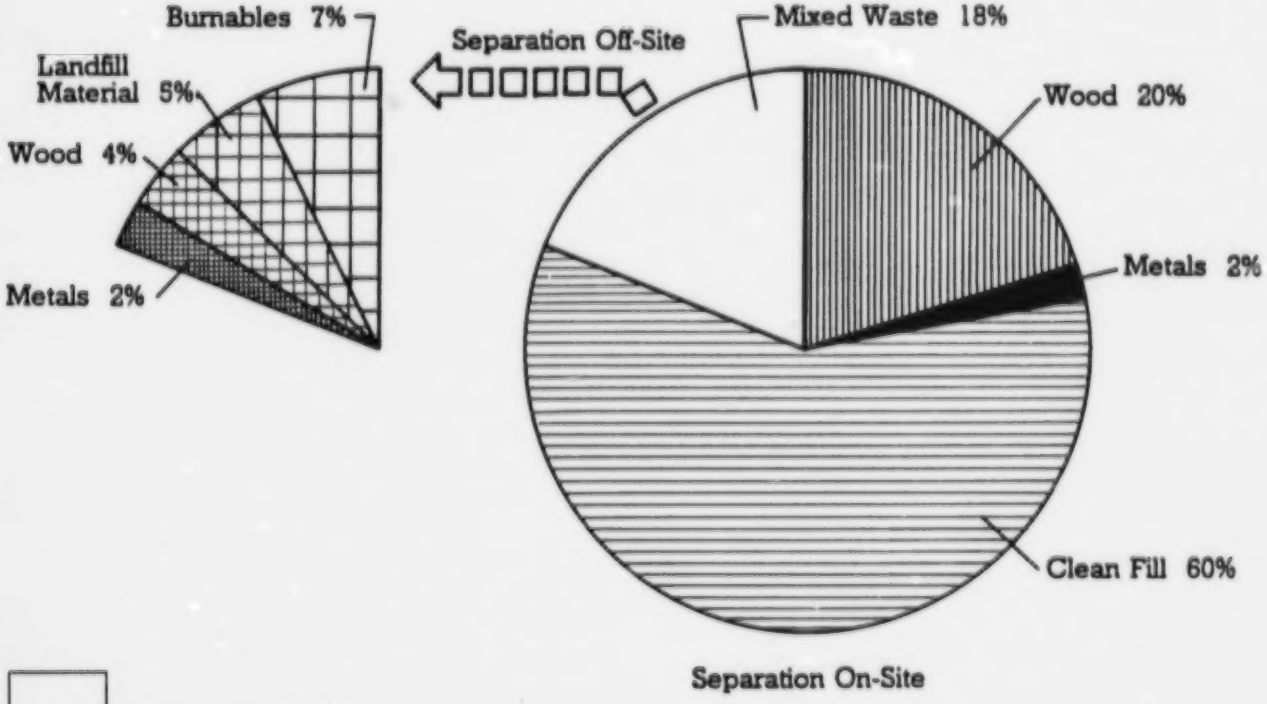


Fig. 8.2 Waste from Apartment Demolition in Switzerland Using Material Separation



to process the separated material. Generally metal, wood, burnables and clean fill are the main divisions.

The following example illustrates the savings achieved through source separation.

The analysis is based on a three storey apartment building of 1,700 square meters, using concrete floor and brick wall construction. The demolished building resulted in 1,300 cubic meters of waste. Using traditional demolition methods and waste material handling, only about ten per cent could have been reused as clean fill. The rest would have ended up in a landfill. (See Figure 8-1).

The results achieved implementing waste separation are illustrated in Figure 8-2. On the demolition site 82 per cent of the waste volume was separated as clean fill, metals and wood. Through further sorting of the remaining 18 per cent mixed waste, more materials were recovered and a small portion was incinerated. The amount of waste ending up in the landfill was finally reduced to 5 per cent of the total original demolition waste.

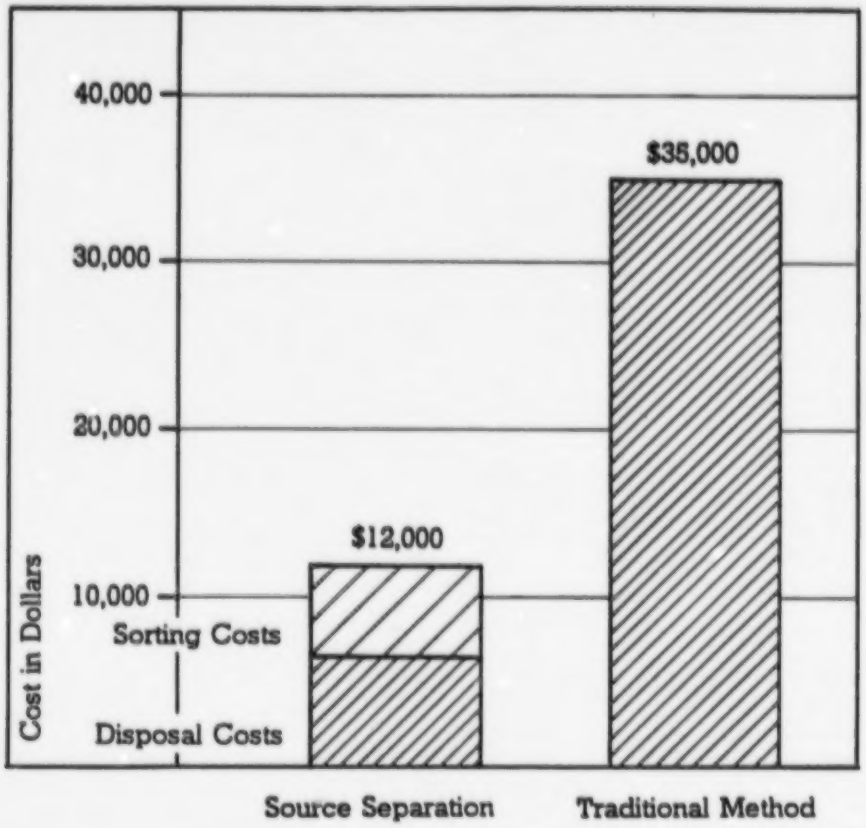
This approach is financially attractive and solves the waste handling problem. (See Figure 8-3). The waste disposal costs using traditional practices cost $35,000. The new method resulted in dramatically reduced disposal charges, but increased labour costs. Nevertheless, the total waste disposal costs amounted to $12,000, resulting in a 65 per cent savings. The detailed costs for implementing waste separation are illustrated in Figure 8-4.

When comparing this example to our local conditions, not only is there a difference in construction methods and hence demolition waste composition must be kept in mind; there is also a difference in waste disposal costs. These are significantly lower in BC. The disposal costs for 1,300 cubic meters of demolition waste are $6,000. Thus the additional separation costs would hardly be covered by today's tipping fees savings. However, with the reduction of available local landfill space, especially in the Lower Mainland, disposal fees are likely to increase and demolition waste separation will become more attractive. Introduction of specific materials bans, for instance the wood ban already practiced in Toronto will further support waste separation. (See Section 6).

8.3.2 Construction Industry Association Project in Basel

Translated and summarized from a series of articles in the Basler Zeitung, Aug/Sep 1990.

Fig. 8.3 Disposal Costs: Material Separation vs. Traditional Methods



In the city of Basel, Switzerland, the construction industry association generated and is promoting a new concept for C+D waste management. The long term goal is a global reduction of landfilled waste to one-third of the current amount.

The city of Basel, with a population of 193,000 produces 135,000 tonnes of C+D waste per year. This is about 0.7 tonnes per person (GVRD about 0.4 tonnes), and is projected to grow to over one tonne per person before the end of the century. Currently only about 25 per cent, or 33,000 tonnes is properly separated and reused or recycled. The rest is landfilled.

The project is based on the following three activities:

- C+D waste sorting at the construction site where possible.
- Establish and support a central sorting facility, operated in common by the larger waste hauler companies.
- Encourage special and hazardous waste removal from the construction site by the generating trade.

Construction site sorting successfully resolved several problems:

- space, usually scarce in a city environment;
- staff training and motivation, workers must go through a significant change of habits. They must be provided with clear, easily understandable information;
- additional supervision; experience shows local sorting is as good as the supervision.

The central sorting facility complements the construction site sorting activity. The goal is reducing the amount of landfill waste to 15 per cent of the received material. The sorting process separates recyclable, burnables, and clean filler. The process uses magnetic, mechanical, and manual sorting. Manual sorting provides jobs, some to disabled people.

The following results were achieved at the central sorting facility:

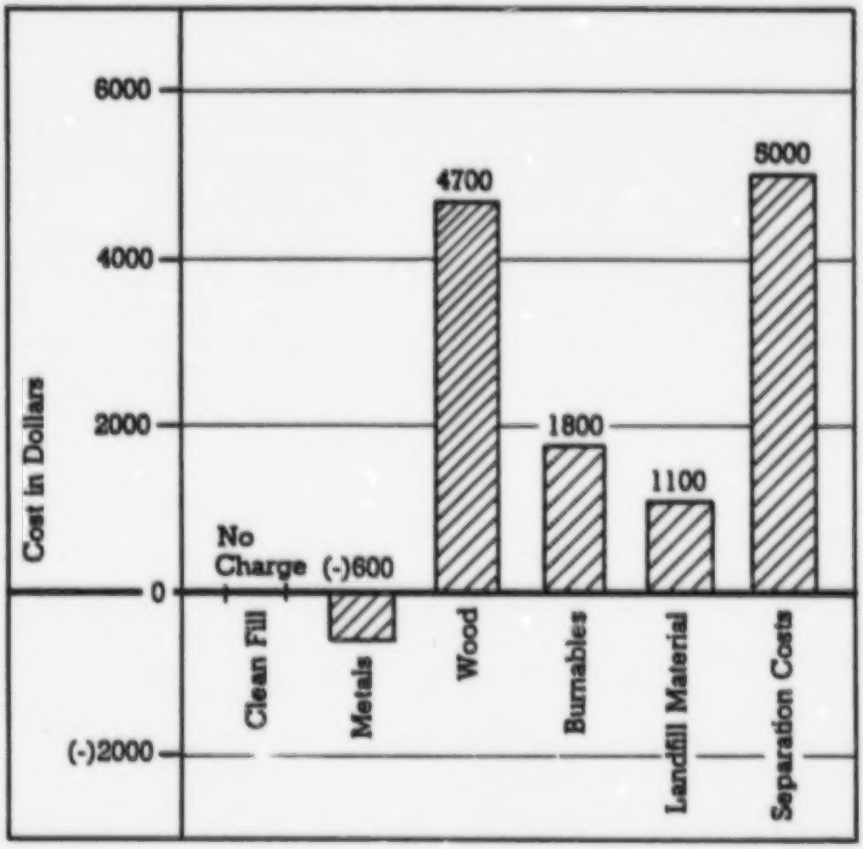
- **metals** very good, almost 100 per cent separated and recycled;
- **wood** good, about 50 per cent recovered and use for chipboard or as fuel in a cement manufacturing plant;
- **larger stones and concrete** very good, 100 per cent reused for roadbeds;
- **small stones and gravel,** separation good, market value poor, problem is'new' gravel is still cheaper.

The central sorting facility operates at a small loss and is supported by public funding. In the near future waste sorting will become more profitable due to stricter guidelines on what landfill sites can accept.

Special and hazardous waste includes: plastics; motor and hydraulic oils; cleaning agents; caulking and filling materials; paint rests; solvents; and glues. When just dumped together with the other C+D waste, these materials can contaminate the entire container and will turn a whole load of otherwise clean and potentially reusable waste into a problematic load. The goal is therefore to have each individual trade remove their own special and hazardous waste, and thus separate it right away from the other C+D waste. First indications look promising, but a larger amount of available information and a significant training effort will be necessary.

The project is off to a good start. All government construction projects have adopted it and accept the additional costs. Some resistance to the additional costs were experienced from private customers. In the near future, the concept will have to be generally adopted due to more stringent environmental laws on waste disposal. This is a good example of private enterprise initiative combined with some legislative backup to resolve the C+D waste problem with an environmentally conscious approach.

Fig. 8.4 Costs of Material Separation in Switzerland



9.0 SUGGESTED ACTION

Areas of concern were identified while investigating construction materials waste management. Many were observations made during the literature review, interviews and site visits, while others were direct suggestions made by those interviewed. Due to the preliminary status of construction materials waste initiatives, most of the areas identified point to work yet be done.

The recommendations are organized into two Sections. The first, Direct Initiatives, focuses on potential design, construction and manufacturing initiatives which concentrate directly on the physical problem of construction materials waste. The second, Information Initiatives, deals with legislation, education, market and research initiatives addressing the larger framework of policy and information regarding construction materials waste.

9.1 Direct Initiatives

9.1.1 Design Initiatives Encourage:

- ❑ Careful dimensioning and detailing to minimize offcutting.
- ❑ Specification of durable, recyclable materials.
- ❑ Provision of materials produced from recycled or waste products.
- ❑ Specification of materials which have lower energy intensities and are made with lower environmental impact processes.
- ❑ The use of locally produced materials.
- ❑ Renovation of sound buildings where appropriate.
- ❑ Design of building which use space and materials efficiently.
- ❑ Contracts that require proper waste management plans from the contractor.

9.1.2 Construction Site Initiatives

- ❑ Identify and train people on site to be responsible for construction materials waste management.
- ❑ Implement source separation on construction sites.
- ❑ Encourage better reuse of offcuts and other scrap on site.
- ❑ Implement careful construction scheduling to reduce waste, redundancy of effort and excess transportation.

9.1.3 Construction Materials Manufacturing Initiatives

- ❑ Promote the development of new construction materials which have lower environmental impact and utilize waste and recycled products.
- ❑ Promote the reduction of packaging materials for construction components and the use of recycled packaging products.

9.1.4 Waste Handling Initiatives

- ❑ Encourage the development of transfer stations for sorted construction materials waste, and possibly the development of sorting stations which would receive (for a fee) unsorted waste for

separation from those sites where source separation cannot be practiced.

- ❑ Promote the development of separated waste containers and trucking methods for construction materials waste.

9.2 Information Initiatives

9.2.1 Research Initiatives

- ❑ Undertake research to better quantify and characterize construction waste.
- ❑ Undertake several detailed case studies of construction site waste and deliveries to landfills.
- ❑ Pursue research into the environmental impact of building materials.
- ❑ Pursue research into the reprocessing of construction materials waste.

9.2.2 Legislation and Policy Initiatives

- ❑ Promote material recycling at construction and demolition waste landfills.
- ❑ Promote separation and safe collection of hazardous waste materials.
- ❑ Encourage the use of recycled products and more environmentally sound materials through tax incentives.
- ❑ Develop long term policy guidelines for the construction industry and material manufacturers so construction materials waste management improvements can proceed in an orderly manner.
- ❑ Provide further renovation inducements through a differential fee structure on demolition permits.
- ❑ Review of procedures (and their enforcement) regulating the disposal of special and hazardous construction and demolition wastes.

9.2.3 Education Initiatives

- ❑ Encourage conservation codes for design professionals and builders to be developed and administered by the respective professional organizations.
- ❑ Implement a demonstration construction site project to educate builders and the public about available construction materials waste management methods and those being developed.
- ❑ Establish levels on acceptable waste generation by materials and products used in construction.
- ❑ Develop a database on waste generation by materials and products used in construction, its disposal and environmental hazards.

9.2.4 Market Initiatives

- Develop incentive programs for business ventures in recycling, processing and remanufacturing of construction materials waste.
- Promote a market information exchange about available recyclable materials in the construction industry.
- Provide for better access by salvage businesses to recoverable materials before demolition.
- Promotion of green builders to the public.
- Develop an award program for public and peer recognition of individuals and companies who implement exemplary conservation methods.

10.0 APPENDIX - REFERENCE GUIDE AND BIBLIOGRAPHY

10.1 Reference Guide Database of Contacts

This list is useful but not exhaustive.

Hazardous Materials

Anderson Newalta Environmental Services
plastics, chemicals, oils, catalysts
108-12851 No. 5 Road, Richmond
277-6262

BC Hazardous Waste Management Corporation
384-5342
Crown Corporation which was established to deal with industrial, business, household and government hazardous wastes.

International Solvents Corp.
9800-190th Street, Surrey
888-4653

Recycling Directory

Architectural Clearinghouse Edmonton Alta.
(403)479-0079 fax (403)479-7700
Maintains a database of fixtures in buildings which are to be demolished.

Recycling Council of BC.
731-7222

Recycling Hotline for CRD
383-2696

Recycling Hotline for GVRD
736-8636

Waste C+D Processing Facilities

Pacific Topsoils Inc.
14002 35th Ave S.E. Bothell, Washington 98012
(206) 337-2700
Plant in Bothell Washington which composts C+D debris.

Wastech Services Limited
Resource Recovery Facility
1200 United Boulevard, Coquitlam
521-1715 or 521-4871
Accepts loads of clean wastes for processing.

Wiggins Disposal Yard
431-7311
Condenses loads of C+D waste and recovers valuable components before sending into a landfill.

Companies Selling Used Building Materials

C+D Used & New Building Materials Ltd.
5620-198th Street, Langley
530-8005

Harco Services Ltd.
23434 River Road, Maple Ridge
467-3445

Jack's Used Building Materials Ltd.
4912 Still Creek Avenue, Burnaby
299-2967

Litchfield and Co. Ltd.
3040 Westwood, Port Coquitlam
464-2222

Mike's New and Used
3871 River Road, West Ladner
946-9747

Old House and Home
2507 West Broadway, Vancouver
731-2516

P & B Used Building Materials Ltd
11947 Tannery, Surrey
588-1311

Companies which recycle materials

Allure Industries Corporation
1480-1176 West Georgia Street, Vancouver
683-8780
Incinerates paint sludge to recover titanium dioxide.

Ames Paints
386-0214
Has a plant in Victoria which recycles paint.

Columbia Bitulithic Ltd.
2300 Rogers, Coquitlam
521-8811
Accepts truckloads of clean asphalt and concrete to reprocess into road bed materials.

E.P.S. Recycling Incorporated
Box 4300, Aldergrove
533-4777 or 533-1234
Grinds landclearing waste for fuel and soil cover.

New West Gypsum
888-2282 fax 888-5126

Pyrotech Asphalt Equipment Manufacturing Co. Ltd.
90 Harbour Avenue, North Vancouver
988-5569
Manufactures machines which recycle asphalt pavement in situ.

United Lock-Block Limited
12600 Mitchell Road, Richmond, V6V 1M8
325-9161
Uses waste concrete to form blocks for gravity retaining walls.

Cardboard Recycling

Bengert Recycling Ltd.
4620 Westlawn, Burnaby
294-1094

International Paper Industries Ltd.
6362-148th Street, Surrey
596-4777
132 Riverside, North Vancouver
929-7377

Paperboard Industries Corporation
85 West First
875-1635

Scrap Metal Dealers

A&A Trading Co.
444 Robson Street, Vancouver
255-4822

A B C Traders Ltd.
8081 Meadows, Burnaby
522-9727

Allied Salvage and Metals (1985) Ltd.
11911 Mitchell Road, Richmond
322-6629

Capital Salvage Co.
1919 Triumph Street, Vancouver
253-8481

Crown Salvage and Metals
2540 No. 5 Road, Richmond
270-1019

Richmond Steel Recycling Ltd.
11760 Mitchell, Richmond
324-4656

10.2 Bibliography

Altenpohl, D. 1980. Materials in World Perspective. New York: Springer-Verlag.

Basler Zeitung. August-September 1990. (Series of articles on the handling of construction waste in Switzerland)

British Columbia Building Permits by Type 1986-89. 1990. Ministry of Finance and Corporate Relations. Victoria: Planning and Statistics Division, Ministry of Finance and Corporate Relations.

British Columbia Municipal Solid Waste Management Task Force. 1989. A Solid Waste Management Strategy for British Columbia. Victoria: Queen's Printer.

Chatterjee, S. et al. 1977. Predictive Criteria for Construction/ Demolition Solid Waste Management. US Army Report N-14 Construction Engineering Research Laboratory, Columbus, Ohio:

Battelle's Columbus Laboratories. NTIS file AD A031419.

Darcovich, Olga. 1990. Construction Waste. Journal of Commerce. Series of three articles August 6,13,20.

Greater Vancouver Regional District. 1988. Brief to Ministry of Environment Task Force on Municipal Solid Waste Management. Burnaby: Greater Vancouver Regional District.

Building Research Establishment. 1985. Waste of Building Materials. Garston, Watford: Publication Sales Office, Building Research Station.

Energy Potential From Construction and Demolition Wastes. 1977. Fort Washington PA: JACA Corporation. NTIS files PB 265 392.

Fennell, J. 1990. A Balancing Act. Canadian Building. May p.28-30.

Gram, K. 1990. Demolition Waste Deplored. The Vancouver Sun. Tues. 17 July.

Haseltine, B.A. 1975. Comparison of Energy Requirements for Building Materials and Structures. The Structural Engineer. no. 9, vol. 53: 357-365.

Looking at No. 1 in Waste Management. 1989. BC Talks Business. vol. 1 #1 p.14.

MacLaren Engineers and Recycling Development Corporation of Canada, 1989. Waste Reduction and Recycling in the GVRD: A Blueprint for Comprehensive Resource Management. Burnaby: Greater Vancouver Regional District.

Meyer, Frank et al. 1983. Study of Hot Mix Recycling of Asphalt Pavements. Ottawa: Transport Canada.

Meyer, Frank et al. 1983. Study of Hot Mix Recycling of Asphalt Pavements: Summary Report. Ottawa: Transport Canada.

Ministry of Environment. 1990. Guide to the Preparation of Solid Waste Management Plans by Regional Districts. Victoria: Queen's Printer.

Ministry of Environment. 1990. Review of Landfill Objectives for Municipal Landfills. Victoria: Queen's Printer.

Ministry of Environment and Parks. 1986. Pollution Control Objectives for Municipal Type Waste Discharges in British Columbia. Victoria: Queen's Printer.

Ministry of the Environment. 1988. The Provincial Role In Municipal Solid Waste Management: A Discussion Paper. 1988. Victoria: Queen's Printer.

Murphy, K.S. et al. 1977. Development of Predictive Criteria for Construction and Demolition Solid Waste Management. NTIS file AD A033646.

National Research Council (US) Transportation Research Board. 1978. Recycling Material for Highways. Washington: National Research Council.

Newell, J. Recycling Britain. New Scientist. Sept.1990. p.46-55.

Pawley, M. 1982. Building for Tomorrow: Putting Waste to Work. San Francisco: Sierra Club Books.

Peat Marwick Stevenson and Kellogg and The Recycling Development Corporation. 1990. A Market Development Plan for Recyclable Materials in British Columbia: Technical Report. Victoria: Ministry of Environment.

Pyrotech Paves the Way in Recycling. British Columbia Talks Business. vol.2 #3 p.8.

REIC Consulting and Renovation Consultants. Making a Molehill Out of a Mountain. Toronto: Toronto Home Builders Association.

Renfroe, O.S. 1979. Building Materials From Solid Waste. New Jersey: Noyes Data Corporation.

Skoyles, E.R. 1984. An Approach to Reducing Materials Waste on Site. Ascot, Berkshire: The Chartered Institute of Building Technical Information Service. NTIS file PB85 200616.

Skoyles, E.R. 1982. Waste and the Estimator. Ascot, Berkshire: The Chartered Institute of Building Technical Information Service. NTIS file PB84 176338.

Skoyles, E.R. and J.R. Skoyles. 1987. Waste Prevention on Site. London: Mitchell.

SPARK Construction Committee Planning Report. 1988. Burnaby: Science Council of British Columbia.

Spencer, R. 1990. Opportunities for Recycling C&D Debris. Biocycle. July p.56-58.

Spencer, R. 1989. Recycling Opportunities for Demolition Debris. Biocycle. November p.42-44.

Statistics Canada. 1988. Building Permits: Annual Summary. Catalogue #64-203 Ottawa: Supply and Services Canada.

Statistics Canada. 1989. Construction in Canada 1987-1989. Catalogue #64-201 Ottawa: Supply and Services Canada.

Staub, Peter. 1990. Source Separation of Construction and Demolition Waste. Bau Bio Bulletin. Feb.

Timmenga H.J. and G. Coombs. 1990. Waste Audit and Recommendations for the Recycling Plan for the District Municipality of Whistler. Vancouver: BC Research.

Wiesman, R.M. and D.G. Wilson. 1976. An Investigation of the Potential for Resource Recovery form Demolition Wastes. Cambridge, Mass: Massachusetts Institute of Technology. NTIS file PB262 339.

Wood, L.E. (ed.). 1977. Recycling of Bituminous Pavements: Symposium Proceedings. St. Louis: Society for Testing and Materials.